Indian Institute of Technology Indore
Master of Science in Data Science and Management

DSM 517 - Advanced Applied Bayesian Inference for Data Science

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Group Project

Dynamic Pricing Models with Bayesian Neural Networks

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Problem Statement

Dynamic pricing is crucial for e-commerce platforms, where prices fluctuate based on demand, competition, and customer behavior. Traditional methods often fail to address uncertainty in data, leading to suboptimal decisions. This project aims to build a **Bayesian Neural Network (BNN)** to predict optimal prices while quantifying uncertainty, thereby maximizing revenue and enhancing customer satisfaction.

Source of Data: Dataset: Online Retail II Dataset

Model

Bayesian Neural Network (BNN) with Softmax outputs for price range classification.

- **Input Features**: Quantity sold, customer ID, product popularity, time of day, day of the week.
- **Output**: Probabilities of price ranges (e.g., discounted, regular, premium).
- **Metrics**: Classification Accuracy, Expected Calibration Error (ECE).

Methodology

The data will be preprocessed to clean transactional records, normalize features, and engineer time-based variables. Bayesian Neural Networks with Hamiltonian Monte Carlo sampling will estimate posterior distributions. The model will be trained using Negative Log Likelihood (NLL) and validated using posterior predictive checks, classification accuracy, and Expected Calibration Error (ECE). Finally, simulated competitor pricing will test real-world scenarios